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A DASHBOARD FOR NEAR-REAL-TIME AIR POLLUTION EPISODES ANALYSIS AND SUPPORT TO DECISION MAKING

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Abstract: In this work, the web platform *calicantus* is described, a service developed to collect and visualize air quality data. Most of the Italian regional environmental agencies take part in this project and share air quality observed data, every day. Through an interactive web interface, the registered user can explore and analyse the data. Interactive maps, cluster analysis, time series analysis and other tools facilitate the visualization and help the interpretation of past pollution episodes and of the current situation. Furthermore, air quality forecasts for today and three days ahead - provided by the Copernicus Atmosphere Monitoring Service - are shown.

Key words: *PM10, ozone, nitrogen dioxide, PM2.5, episode analysis, web tool, cluster analysis, interactive visualization, decision support.*

INTRODUCTION

In Italy environmental protection, including monitoring, is mainly carried out by the environmental agencies of each region (ARPA) or autonomous province (APPA), with the coordinating role of the National Institute for Environmental Protection and Research (ISPRA)[1]. This network-shaped organization – now called National System for Environmental Protection (SNPA) - was defined by the recent primary law no.132 (come into force in January 2017). While assuring an extensively branched and flexible deployment of resources, it still requires an effort in order to guarantee effective data collection, sharing, harmonization and publication at a national level, in particular when dealing with up-to-date data.

In order to fill this latter gap, providing an up-to-date overview on Italian air quality, available at least for air quality experts, the web platform *calicantus*[2] has been developed. The platform helps air quality experts in the interpretation of high pollution episodes and in the validation of observed data.

PLATFORM DESCRIPTION

To face the heterogeneity of data formats, metadata availability, protocols used for data transfer, data supply timing, data models, etc., the observed data collection phase of *calicantus* (top left side of Figure 1) was developed with an adaptive approach, in the sense that flexibility is required to the data gatherer, rather than to the data providers.

To date, *calicantus* collects PM10 daily data from most (13) of the Italian regional environmental agencies and ozone, NO_2, PM2.5 from 7 of them. The participation, as data providers, of environmental agencies of the European and Mediterranean area is welcome. As a matter of fact, data from "Dipartimento del Territorio Cantone Ticino" (Switzerland) and Croatian Environment Agency are already in our data stream. Data collectors from ANPE Tunisia, ARSO Slovenia and European Environment Agency (EEA) are under construction.

[1] http://ambienteinforma-snpa.it/le-reti-di-monitoraggio-della-qualita-dellaria-in-tutte-le-regioni/
[2] "calicantus" is an acronym that stands for "collect all the information you can on air quality - near-real-time or at least up-to-date - and show it"

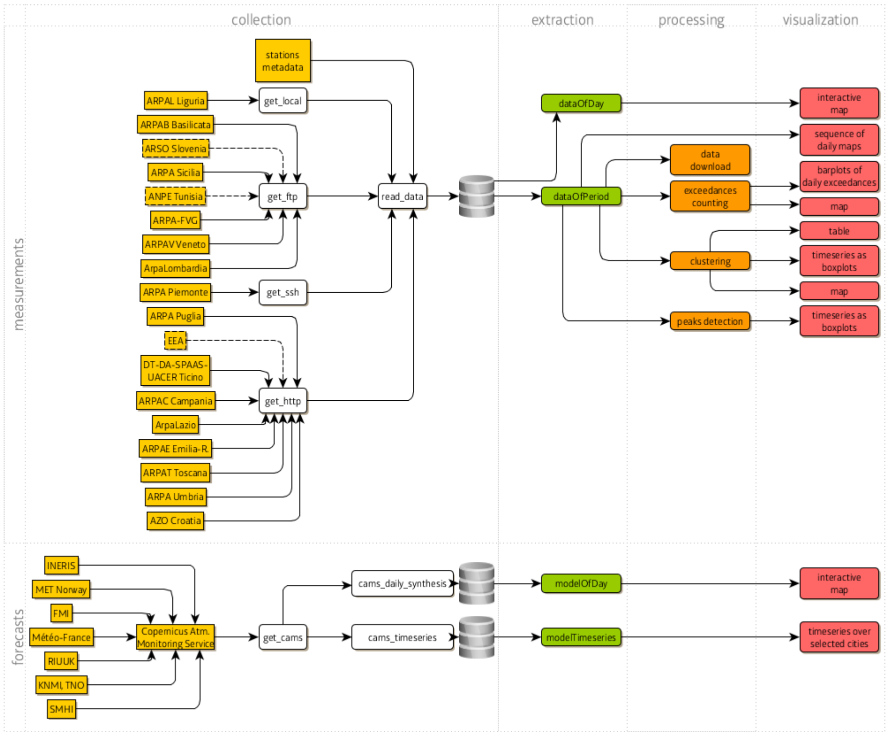

Figure 1. Flowchart of the *calicantus* platform

Furthermore, air quality forecasts (for PM10, ozone and PM2.5) for today and three days ahead are collected, provided by seven chemistry-transport models of the Copernicus Atmosphere Monitoring Service[3] (CAMS).

The access to the platform[4] is reserved to air quality experts of the public environmental agencies and, with some restrictions, to researchers, air quality modelling experts and public administrators. To date, 42 users are registered to the *calicantus* service: 24 environmental agencies, 5 environmental consulting companies and 13 research groups, from Italy, Switzerland, Slovenia, Croatia and Tunisia.

After the data collection processes, which are automatically scheduled many times a day, the following phases – extraction, processing and visualization (right side in Figure 1) – are interactively triggered and customized by the user through the web interface. Observations and forecasts are shown on interactive maps (Fig.2), tables and time series on user-selected cities (Fig.6). Exceedances of user-defined thresholds can be visualized aggregated in time on a map or aggregated in space as time series (Fig.3). Time series of observed concentrations are shown as a sequence of daily maps (Fig.4) and as daily box-and-whiskers plots (Fig.5), where peaks are selected with customizable criteria and labelled, in order to help in identifying local hot-spots or measurement problems. Furthermore, the cluster analysis tool (Maechler *et al*, 2017) can identify areas where air pollution was relatively homogeneous during a selected period.

Disk space usage of the archive is about 4 GB per month for the CAMS data and about 5 MB per month for the observed data. The platform code is written in the R language (R Core Team, 2017) and available on a public repository (Bonafè, 2017). Suggestions for further developments and reporting of errors are welcome.

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[3] https://atmosphere.copernicus.eu/documentation-regional-systems
[4] https://sdati.arpae.it/calicantus-intro/

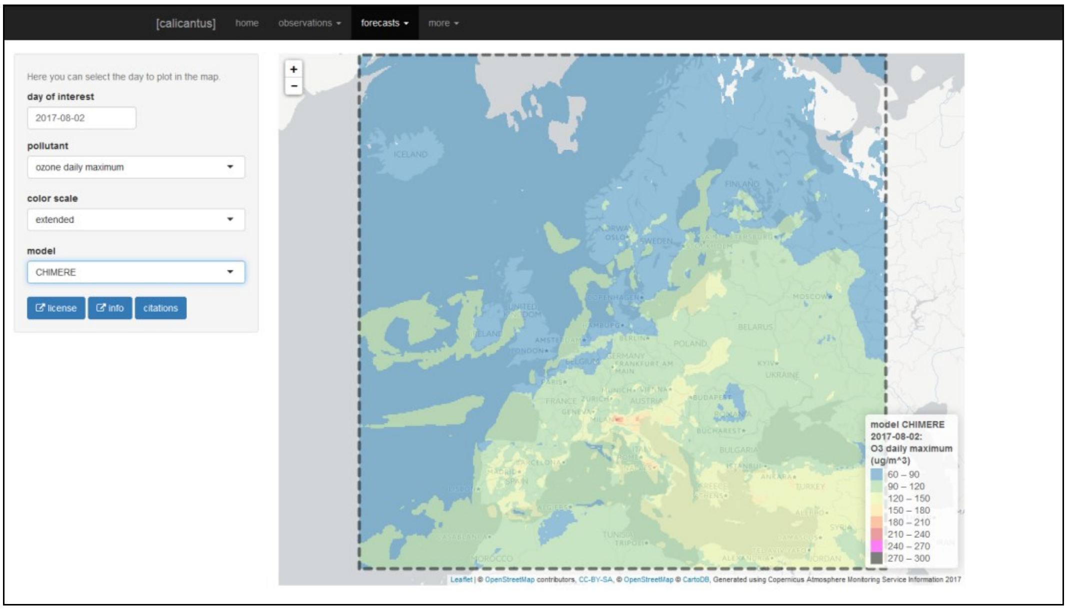

Figure 2. Air quality forecast: *calicantus* provides interactive map (generated using Copernicus Atmosphere Monitoring Service Information 2017)

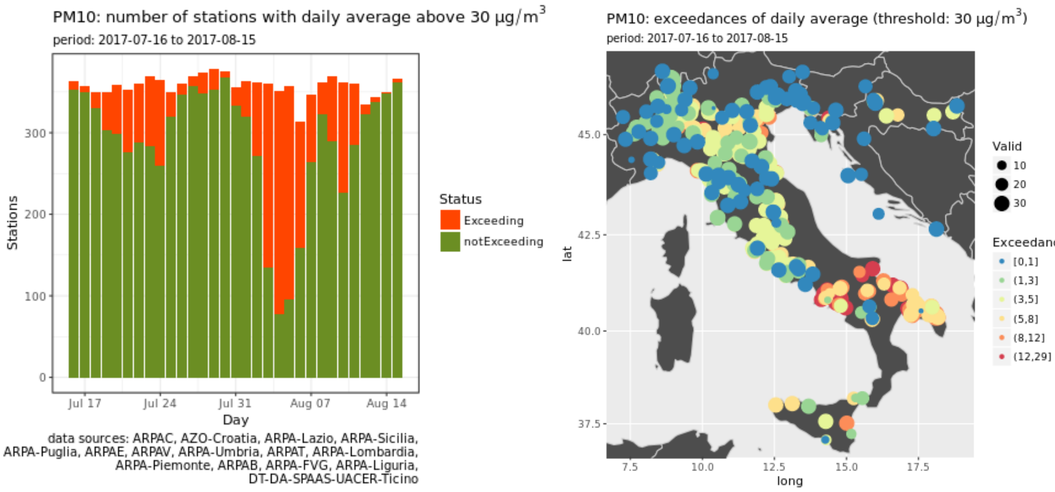

Figure 3. Example of *calicantus* products. Time series (left) and map (right) of exceedances of a threshold can help in analysing duration, frequency and extension of the air pollution episodes.

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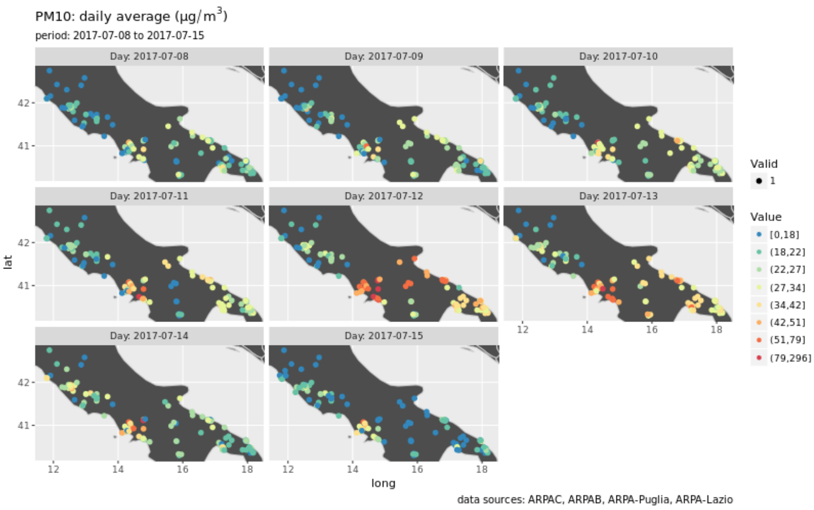

Figure 4. Example of *calicantus* products. The sequence of maps of PM10 concentrations gives an overview of the evolution of an air pollution episode: the large fires on the Vesuvius volcano affected air quality in Southern Italy; July 12th 2017 the plume increased PM10 concentration not only in Campania, but also in the Northern parts of Basilicata and Apulia

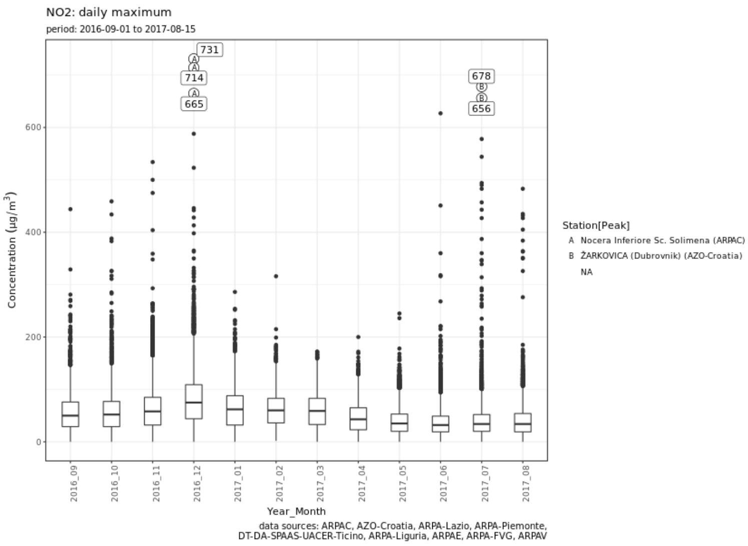

Figure 5. Example of *calicantus* products. Timeseries of daily box-and-whiskers plots, where peaks are selected with customizable criteria and labelled, can help in identifying local hot-spots or measurement problems. Nitrogen dioxide concentrations measured in Dubrovnik, Croatia, in summer 2017, and in Nocera, Italy, in winter 2016 were particularly high.

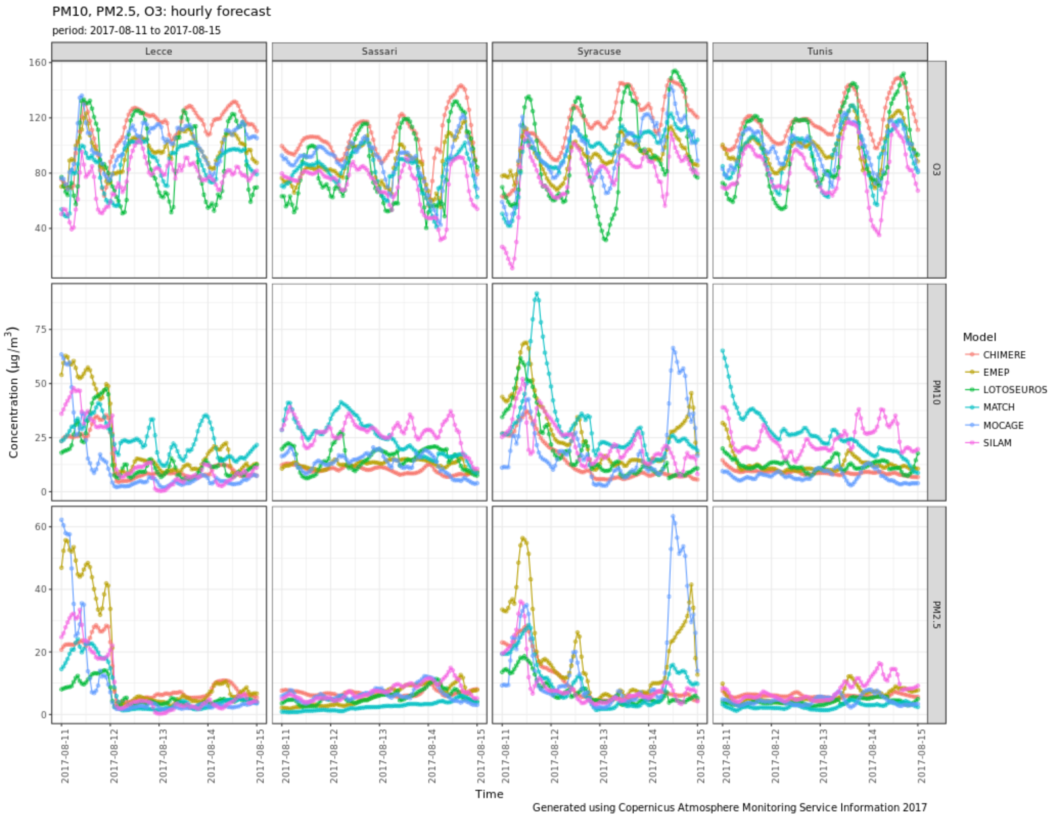

Figure 6. Hourly forecasts are provided on cities selected by the user (generated using Copernicus Atmosphere Monitoring Service Information 2017). The spread of the seven CAMS models can be operatively considered as an estimation of the uncertainty of the forecast. In this case, for Eastern Sicily and Southern Apulia a Saharan dust transport was forecasted for 11th August, but there was no agreement about the concentrations of aerosol at the surface.

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